suggested that the injurious effects of a toxic element could be counteracted by an excess of a chemically similar nutritive element, the assumption being that such elements would enter the plant alike without selective discrimination (but with unlike effects on the plant). If the gradient established by the plant's metabolism of the nutritive element should determine the total absorption of the two, the amount of the toxic element taken in would decrease as the proportionate amount of the nutritive element in the substratum increased. The experimental results showing reproducible ratios associated with given degrees of injury to the plant in the case of arsenic and phosphorus as well as of selenium and sulphur were in accord with this supposition, and, in fact, could only be explained on some such line of reasoning.[4]

The confirmation of the idea supplied by the arsenate/phosphate relation led to the testing of other similarly related pairs of elements. The pairs that could be selected on this basis were very limited, since, other than sulphur and phosphorus, there are only five major mineral nutrients—nitrogen, iron, magnesium, potassium, and calcium. Next to potassium in Division A of Group I is the toxic element rubidium, and next to calcium in Division A of Group II is the moderately toxic strontium. These two pairs were accordingly chosen for experimentation.

The plants were grown in nutrient solutions, according to procedures described in the earlier papers. For the study of rubidium toxicity, low- , medium- and high-potassium solutions were made by varying the amounts of KCl in otherwise identical solutions. Their pH values were brought near 6.5 with equal amounts of NaOH. Controls without rubidium showed that plant injury in the low-potassium cultures containing rubidium was not due to the low KCl content. In some of the experiments duplicate series of the low-KCl cultures were set up, for one of which the low chlorine content was compensated for by adding sufficient calcium chloride to make the chlorine equal to that of the high-potassium solution. The plants of these cultures gave evidence that neither chlorine nor calcium was a factor in the results.

The characteristic symptom of the injury produced by rubidium chloride on both wheat and barley was a stunting and peculiar thickening of the roots, resulting eventually in stunting of the tops also. The

[4] The antagonism is much more marked with selenates than with selenites, so it should be emphasized that only sodium arsenate ($Na_2HAsO_4 \cdot 7H_2O$) has been used in studying the arsenic/phosphorus relation.

degree of injury varied with the proportionate amount of potassium present, twice as much potassium as rubidium effectually preventing the appearance of the root injury. Thus with 60 p.p.m. of rubidium, injury could be detected in both wheat and barley with 60 but not with 120 p.p.m. of potassium; with 120 p.p.m. of rubidium, there was definite injury with 150 but not with 240 p.p.m. of potassium.

For the study of strontium toxicity, low- , medium- and high-calcium solutions were made by varying the amounts of calcium nitrate, the resulting differences in nitrogen being compensated for by the addition of requisite amounts of ammonium nitrate. The pH values of the low- and high-calcium solutions were both near 6.5. Controls without strontium showed that the peculiar injury attributed to strontium in the low-calcium solutions was not due to calcium deficiency.

The characteristic symptom of strontium injury was a stimulation of tillering with stunting, so that the plants were thick, short bunches of as many as twelve tillers instead of the usual four much taller tillers of the controls. The effect was extreme with 500 p.p.m. of strontium supplied as either $SrCl_2$ or $Sr(NO_3)_2$ in solutions containing but 50 p.p.m. calcium, slight with 230 p.p.m. calcium, and absent with 500 p.p.m. calcium. Controls with the same amounts of chlorine and nitrate in the form of potassium salts proved that the effect was produced by the strontium alone. Under the conditions of these experiments, then, strontium produced detectable injury with but half as much calcium as strontium present, but with the amounts equal it was nontoxic. The accuracy of these ratios may be questionable, however, because of a considerable precipitate in the high-calcium flasks, suggesting that the calcium did not all remain in solution.

Tests to determine the specificity of the relations by interchanging the nutrient solutions showed that excess potassium did not inhibit strontium toxicity, nor did excess calcium inhibit rubidium toxicity.

Insofar as the establishment of predicted relations by actual experiment constitutes evidence, the observed antagonism of arsenic, rubidium and strontium by phosphorus, potassium and calcium, respectively, substantiates the generalization suggested by the selenium-sulphur antagonism. Briefly stated, this hypothesis is that in proportion to its relative concentration an essential nutritive element reduces the absorption and consequent toxicity of a toxic element sufficiently similar chemically to preclude selectivity on the part of the plant.

ORNITHOLOGY.—*Descriptions of three new screech owls from the United States.*[1] HARRY C. OBERHOLSER, Bureau of Biological Survey.

The identification of screech owls, *Otus asio*, from various sources, including Texas, has made necessary the examination of a considerable number of these birds from various parts of the United States. In addition to the collection of the U. S. National Museum, including that of the Biological Survey, there have been examined a large number of specimens from other museums and from individuals. The writer is, therefore, indebted for the loan of comparative material to Dr. Frank M. Chapman, Dr. A. I. Ortenburger, Dr. Louis B. Bishop, Dr. Max M. Peet, Professor Myron H. Swenk, Dr. Joseph Grinnell, Dr. Josselyn Van Tyne, Dr. D. Elton Beck, Dr. John W. Sugden, Dr. Vasco M. Tanner, Miss Edith R. Force, Ralph H. Imler, C. D. Bunker, J. L. Peters, H. V. Williams, Edwin D. McKee, C. C. Presnall, E. R. Warren, and C. Lynn Hayward.

Study of the material thus brought together has resulted in the discovery of three apparently new subspecies of *Otus asio*, which it seems worth while to describe. Perhaps the most interesting, as well as the most beautiful, of these is:

Otus asio swenki,[2] subsp. nov.

Nebraska Screech Owl

Subspecific characters.—Similar to *Otus asio aikeni*, of central Colorado, but smaller; in gray phase much paler on the upper surface and somewhat so below, the face lighter, more whitish; both upper and lower parts more finely marked with blackish; in red phase also paler.

Measurements.—Adult male[3]: wing, 153–170 (average, 160.6) mm; tail, 75–82 (78.6); culmen from cere, 13.5–16 (15.2); tarsus, 35–40 (37.6); middle toe without claw, 17–20 (18.6). Adult female[4]: length in flesh (type), 221 mm; wing, 162–169 (average, 164.7); tail, 79–85.5 (82.2); culmen from cere, 14–17 (15.8); tarsus, 36–39.5 (37.6); middle toe without claw, 18–20 (18.9).

Type.—Adult female, collection of Prof. Myron H. Swenk; Chadron, Dawes County, Nebraska, altitude 3,450 feet; February 1, 1918; L. M. Gates.

Geographic distribution.—Resident and breeds in the middle United States, north to central southern Manitoba; west to western Nebraska and central western Oklahoma; south to central western Oklahoma, and central southern Kansas; and east to central Kansas, central eastern Nebraska, western Minnesota, and central southern Manitoba.

Remarks.—The discovery of this interesting new owl came as a decided

[1] Received May 22, 1937.

[2] Named for Prof. Myron H. Swenk, of Lincoln, Nebraska.

[3] Thirteen specimens, from Nebraska, Kansas, Manitoba, Minnesota, and North Dakota.

[4] Ten specimens, from Nebraska, Kansas, Minnesota, and North Dakota.

surprise in the course of a study to determine the actual range of *Otus asio hasbroucki*. From that form it differs so decidedly in its much paler coloration that it scarcely needs comparison. From *Otus asio naevius* in gray phase it differs in its much paler and less coarsely dark-marked upper surface, paler and more whitish face; and in red phase by its decidedly lighter color. From *Otus asio maxwelliae* in gray phase it differs in its decidedly darker and more finely marked upper surface, less whitish face, and darker, i.e., more extensively black-streaked and barred lower surface.

Birds from eastern Kansas (Douglas County, and west to east central Kansas in Harvey County) are darker and mostly more brownish, thus verging so much toward *Otus asio naevius* that they are referable to that race. On the other hand, birds from eastern Nebraska (Lincoln and other localities) are rather darker and more brownish than typical *Otus asio swenki*, and thus verge a little toward *Otus asio naevius*, but they are decidedly nearer to *Otus asio swenki*. While no specimens of this new race from Colorado have been examined, it probably ranges at least to the eastern border of that state. It probably occurs also in the Panhandle of northwestern Texas (although no specimens from that region have been seen), since a specimen from Ellis County, Oklahoma, which borders on the Texas Panhandle, is *Otus asio swenki*.

The examination in this connection of a considerable number of screech owls from central and eastern Oklahoma, Benton County, northwestern Arkansas, with a few from central northern Texas, and from Greenwood County and Cedar Vale, southeastern Kansas, now shows that these areas are occupied by *Otus asio hasbroucki*.

It gives me great pleasure to name this handsome screech owl for Prof. Myron H. Swenk, of the University of Nebraska, who has done so much to advance the study of ornithology in the state of Nebraska. Furthermore, it is appropriate that the bird should be called the Nebraska screech owl, since it apparently reaches its maximum differentiation in that state.

Following is a list of the localities from which specimens of *Otus asio swenki* have been examined:

Kansas: Stockton (Feb. 22, 1936); Hamilton County (Nov. 19, 1934); Wallace County (June 24 and 29, 1911); Comanche County (May 25 and 29, 1911); Coolidge (July 12, 1921).

Manitoba: Winnipeg (June 4, 1930); Deer Lodge, Winnipeg (Nov. 12, 1928).

Minnesota: Beaver, Roseau County (Jan. 7, 1932); Stafford, Roseau County (Nov. 20, 1926); Poklitz, Roseau County (March 3, 1927); Badger, Roseau County (Feb. 27, 1927); Mickinock, Roseau County (March 8, 1930); Dieter, Roseau County (March 10, 1932); Jadis, Roseau County (Dec. 28, 1926).

Nebraska: Spencer (Dec. 14, 1931); Scottsbluff (June 28, 1916); Chadron (Feb. 1, 1918); Lincoln (Nov. 13, 1932; Dec. 26, 1934); Kearney (Dec. 14, 1924); Union (May 6, 1933).